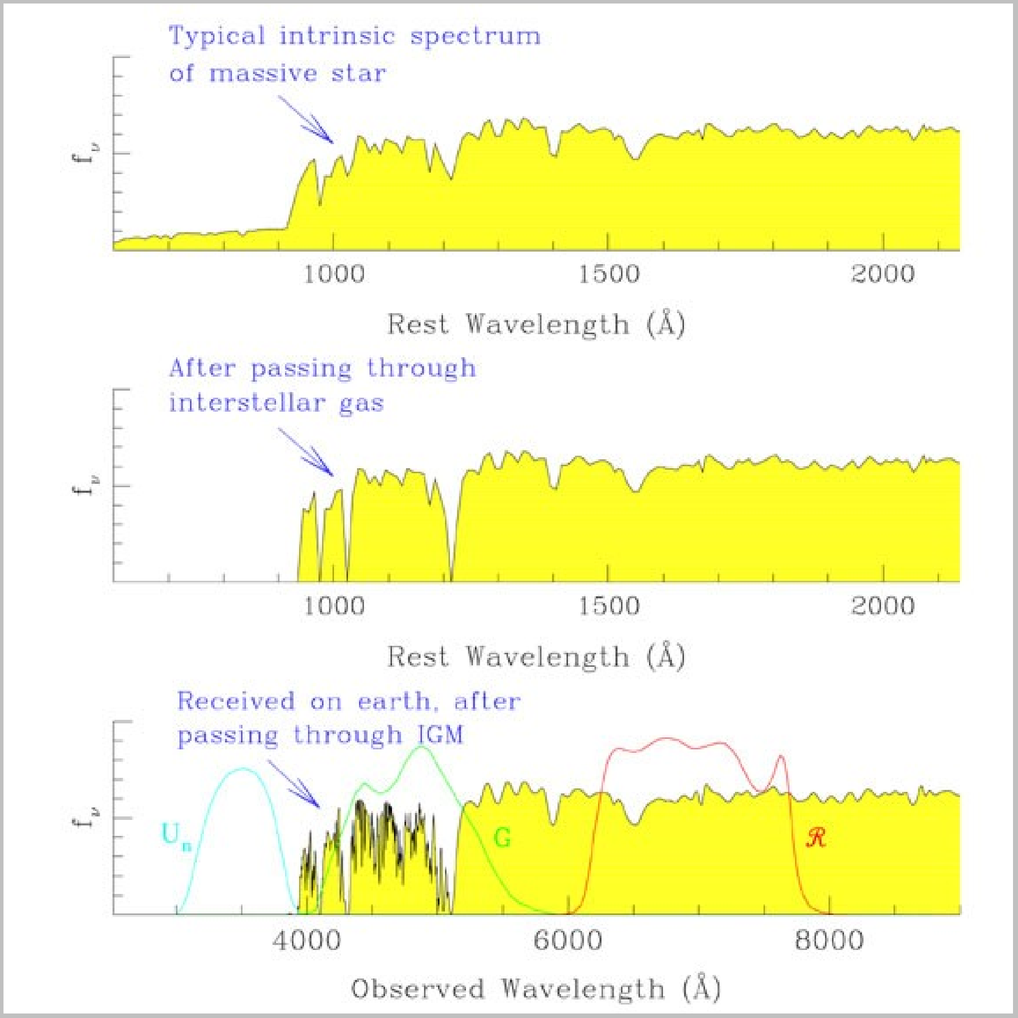
Lyman-Break Galaxies

- Lyman break galaxies are places of very active star formation. Their UV luminosity is directly related to the number of short-lived, high mass stars
- Lyman-break galaxies have colors that satisfy $(U-G) \geq 1.0 + (G-R)$; $(G-R) \leq 1.2$ with an additional requirement $R < 25.5$ imposed to produce a reasonably complete sample suitable for spectroscopic follow-up
- At $z \sim 2.5$ in 1000 Mpc^3 at $z \sim 2.5$, there are 10 Lyman-break galaxies with R-mag < 25.5 and the number of galaxies drops at redshifts > 3 or 4

The rest-frame UV spectra of these galaxies bear close resemblance to those of local starburst galaxies.



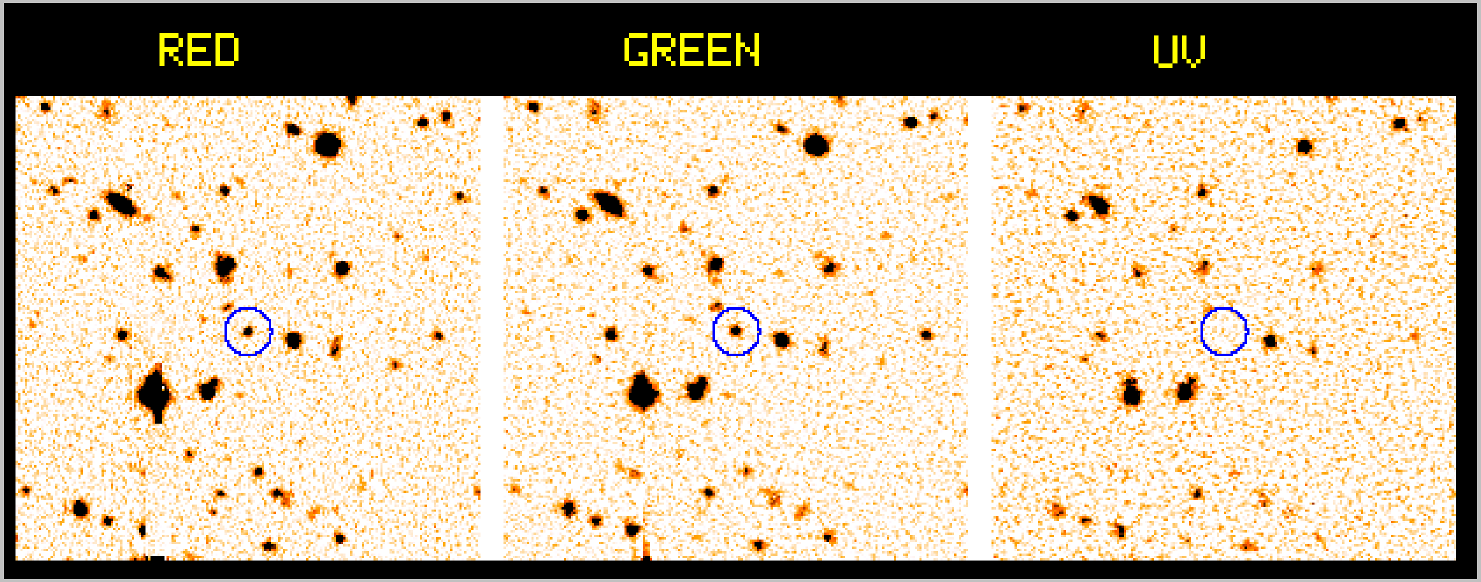
Lyman break galaxy spectrum z~3 from Pettini (2003)

Cosmological Significance

- These data sets are essential to explore properties of early galaxies
  - spectra
  - luminosity function
  - morphology
  - star-formation history
  - clustering
  - mass

These are needed to constrain theories of galaxy formation

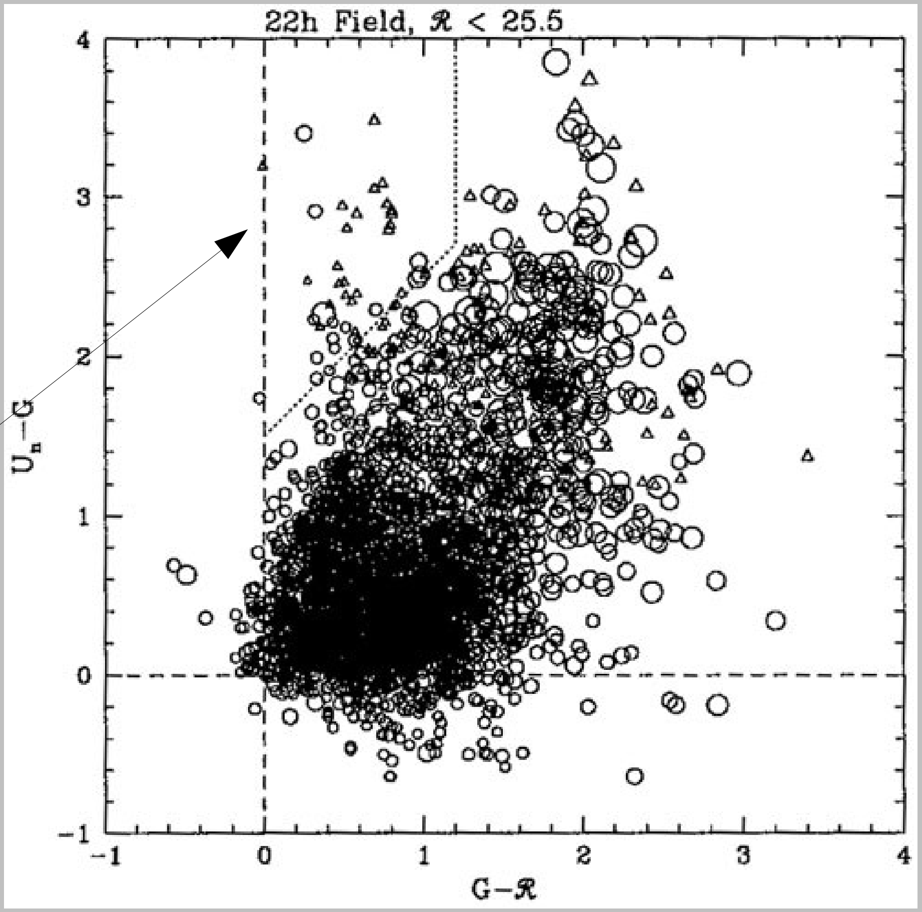
Finding L-α Galaxies



- These are from 200-inch Hale Telescope
- R, G, and UV filters are designed for isolating high redshift galaxies
- Notice UV "dropout"

1,200 *U*-dropouts brighter than ~ 25.5, 418 of them are in the range $2 < z < 4$

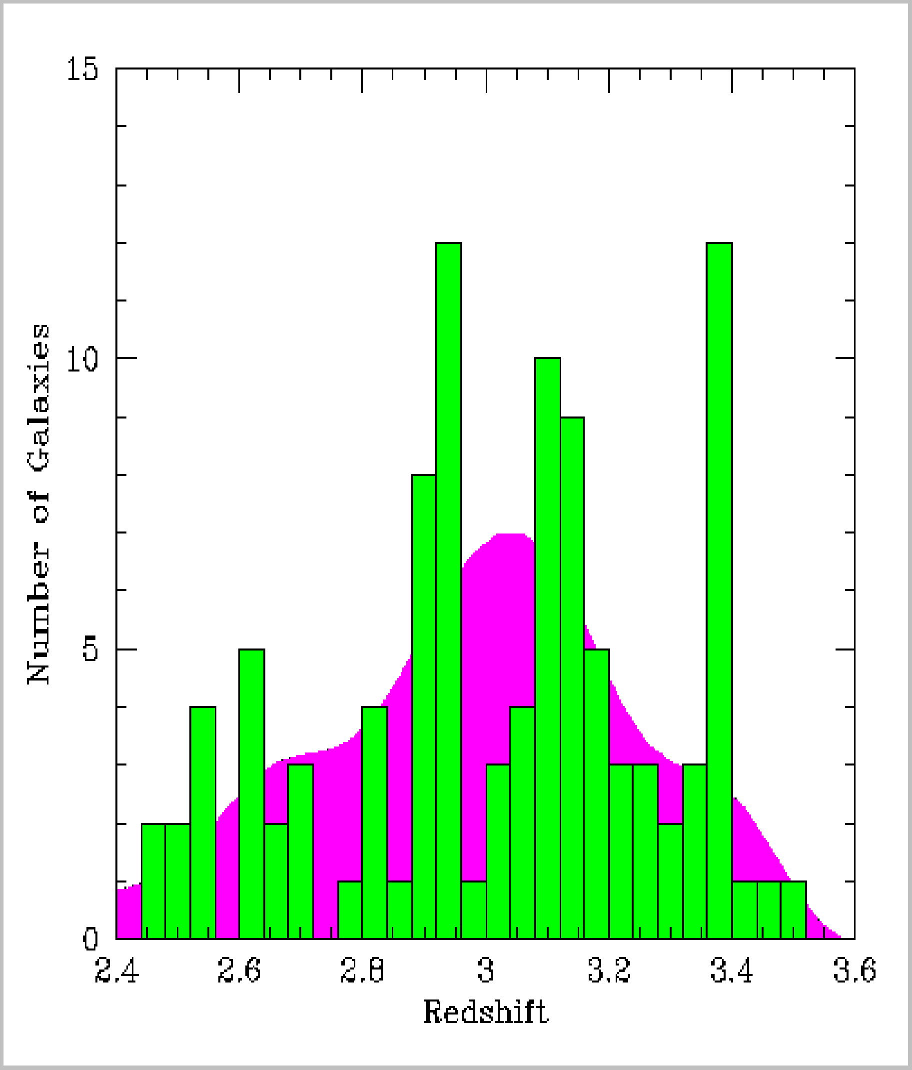
Selection region



Color of Lyman break galaxies @ $z \sim 3$ from Giavalisco (1998) This is the SSA22 field from 200-inch Palomar telescope with the COSMIC camera.
The selection window for Lyman-break galaxies is marked by the dashed line.

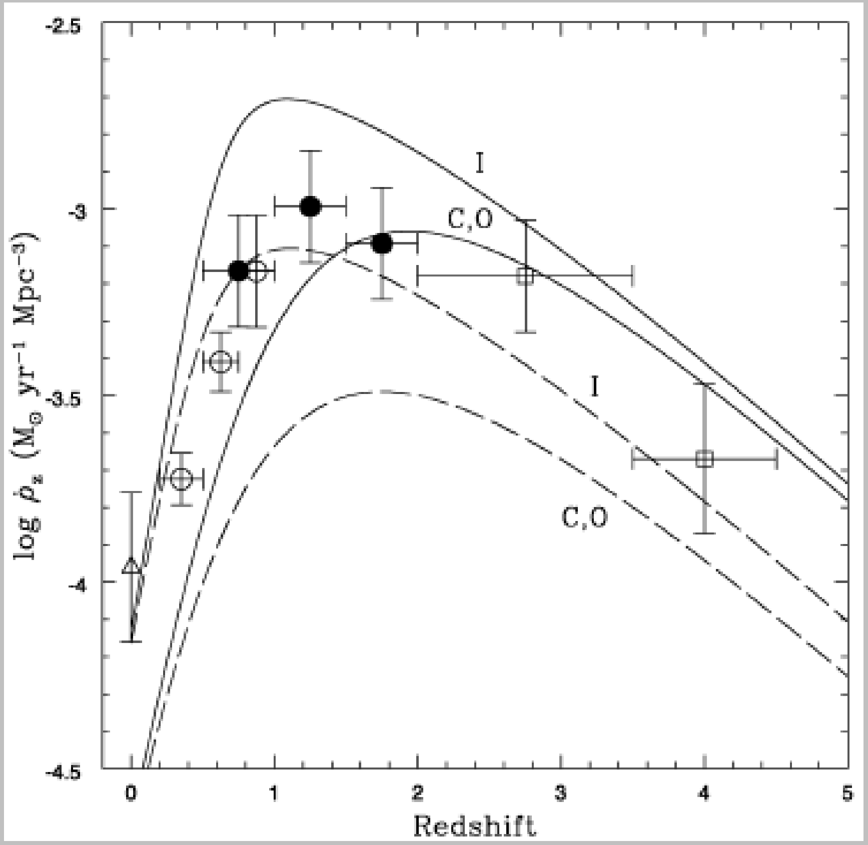
Space Distribution

- Green bars show the data and the solid curve shows a random distribution
- Shows strong clustering
- Consistent with the large scale clustering we discussed



Star formation History

- Metal formation as a function of redshift
- L-α galaxies provide important data at high redshift
- Peak metal production is at z~1.5



Gallego et al. (open triangle), Lilly et al. (open circles), Madau (open squares) and the photometric redshift sample (closed circles)

What Have We Learned?

What is the structure of the Milky Way galaxy?

What are the components of our Galaxy?

Where are stars forming in our Galaxy?

Where are the globular Clusters?

How big is our Galaxy?

Where is the Sun's position in the Milky Way?

Why was the Shapley-Curtis debate important?

Who helped to resolve this debate?

What are proper motions?

What is cluster main sequence fitting?

What is parallax?

What are some of the differences between spiral, elliptical, and irregular galaxies?

What are the different classification schemes? How are they related? How are they different?

What physical characteristics vary among the galaxy types?

How is this related to classification schemes?

What do astronomers mean by the Local Group?

What kind of galaxies make up the local group?

What type of galaxies make up clusters of galaxies?

What are quasars? What are some of their properties?

What are Seyfert Galaxies?

What are Radio Galaxies?

Are Seyfert and Radio Galaxies related? If so how?

Describe the internal dynamics of Spiral galaxies? Of elliptical galaxies. How are they different? How are they similar?

What are spiral arms?

What are the processes that we think may form spiral arms? When are they applicable.

How do we know that the Universe is expanding?

How do we measure this?

What is the Tully-Fischer relation?

Can this be used with elliptical galaxies?

Can this be used with Seyfert galaxies?

What is superluminal motion?

What is gravitational lensing?

What is the origin of large scale structure in the universe?

What are some of the different methods of observing it? Of measuring it?

How is the Hubble parameter related to the expansion of the universe?

What is meant by a radiation dominated universe? A matter dominated universe?

What are peculiar velocities?

Why are quasars important in the study of the early universe?